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SUPERSEDING
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DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION SPECIFICATION

TUBE, SCAN CON-VERSION STORAGE, TYPE 7539

1. SCOPE AND CLASSIFICATION

1.1 Scope.- The 7539 Scan Conversion Storage Tube is a two-gun storage tube for use in a RADAR BRIGHT DISPLAY EQUIPMENT (RBDE-3) Type FA-6905 Scan Converter Equipment for transforming radar, beacon, and other forms of rho-theta video information into television information.

1.2 Classification.- The 7539 Scan Conversion Storage Tube shall have the characteristics (including outline, dimensions, and basing and bulb terminals) listed in this specification and in the EIA Joint Electron Device Engineering Council (JEDEC) registration data as of August 21, 1961, for tube Type 7539. In the event of a conflict between any item covered by both this specification and the JEDEC registration data, this specification shall control.

2.1 APPLICABLE DOCUMENTS

2.1 FAA Specifications.- The following Federal Aviation Administration (FAA) specifications form a part of this specification. Reference made to the following specifications shall apply to the specifications and all amendments thereto at time of contract award.

FAA-R-1213 Radar Bright Display Equipment

2.2 Military specifications.- The following Military specifications, of the issues in effect on date of the invitation for bids or requests for proposals, form a part of this specification to the extent specified hereinafter:

MIL-E-75	Electron Tubes, Packaging of, General Specifications for

(Copies of this specification and other applicable FAA specifications, standards and drawings may be obtained from the Contracting Officer in the Federal Aviation Administration Office issuing the invitation for bids or request for proposals. Requests should fully identify material desired, i.e., specification, standard, amendment, and drawing numbers and dates. Requests should cite the invitation for bids, request for proposals, or the contract involved or other use to be made of the requested material.)

(Information on obtaining copies of Federal specifications and standards may be obtained from General Services Administration offices in Washington, D.C., Seattle, San Francisco, Denver, Kansas City, Mo., Chicago, Atlanta, New York, Boston, Dallas, and Los Angeles.)

(Single copies of Military specifications and standards may be obtained from Federal Aviation Administration, Washington, D.C. 20590, ATTN: Contracting Officer. Requests should cite the invitation for bids, request for proposals, or contract for which the material is needed. Mail requests, if found acceptable, will be forwarded to a Military supply depot for filling; hence, ample time should be allowed.)

3. REQUIREMENTS

3.1 Definitions.-

3.1.1 Normal operating conditions.- The term "normal operating conditions" is defined as follows:

Ambient temperature	400 ± 100 Centigrade
AC line voltage	120 volts single phase
AC line frequency	60 Hz
Scan converter controls	Normal operating settings (see paragraphs 3.4.4 through 3.4.4.3))

3.1.2 Storage Surface.- The term "storage surface" as used herein denotesthe usable area of the storage element; the usable area being the available, unobstructed area, circular in shape, within which all requirements of the storage tube shall be met while operating under standard 'conditions (see 3.4.4 et al.). NOTE: The storage surface is normally

limited by the "boundary ring" (mounting ring, collector ring, shading ring or other mechanical or electrostatic ring), and is usually expressed in terms of percentage of storage element diameter.

3.1.3 Resolution.- The term "resolution" as used herein is defined as the quantity of information which can be written into, stored, and distinguished in the output of the 7539 Scan Conversion Tube under standard conditions (see 3.4.4 et al.).

3.1.3.1 Relative response.- The term "relative response" as used herein is defined as the ratio of the initial (signal amplitude immediately after writing) average (moire and beat effects averaged out) peak-to-peak output signal produced by a test pattern consisting of 25 + 10 equispaced concentric range rings approximately centered on the-storage surface to the initial average peak-to-peak output signal produced by a test pattern consisting of 150 equispaced concentric range rings approximately centered on the storage surface.

3.1.4 Shading.- The term "shading" as used herein means the phenomenon of gradual variation, or small number of gradual variations, in the level of output video due to the characteristics of the storage surface.

3.1.4.1 Signal-to-shading ratio.- The signal-to-shading ratio as used herein is defined as the ratio:

$$R_S = \frac{S_{max}}{S_{max} - S_{min}} \qquad \text{(See Figure 1)}$$

The terms in the ratio shall be measured in accordance with the methods of paragraph 4.6.7.

3.1.4.2 Signal-to-background-shading ratio.- The signal-to-background-shading ratio as used herein is defined as the ratio:

$$R_B = \frac{S_{max}}{B} \qquad \text{(See Figure 1)}$$

S_{max} shall be measured in accordance with the methods of paragraph 4.6.7., and B, the maximum peak-to-peak background shading, shall be measured on an A-scope in accordance with the methods of paragraph 4.6.6.

limited by the "boundary ring" (mounting ring, collector ring, shading ring or other mechanical or electrostatic ring), and is usually expressed in terms of percentage of storage element diameter.

3.1.3 Resolution.- The term "resolution" as used herein is defined as the quantity of information which can be written into, stored, and distinguished in the output of the 7539 Scan Conversion Tube under standard conditions (see 3.4.4 et al.).

3.1.3.1 Relative response.- The term "relative response" as used herein is defined as the ratio of the initial (signal amplitude immediately after writing) average (moire and beat effects averaged out) peak-to-peak output signal produced by a test pattern consisting of 25 + 10 equispaced concentric range rings approximately centered on the-storage surface to the initial average peak-to-peak output signal produced by a test pattern consisting of 150 equispaced concentric range rings approximately centered on the storage surface.

3.1.4 Shading.- The term "shading" as used herein means the phenomenon of gradual variation, or small number of gradual variations, in the level of output video due to the characteristics of the storage surface.

3.1.4.1 Signal-to-shading ratio.- The signal-to-shading ratio as used herein is defined as the ratio:

$$R_S = \frac{S_{max}}{S_{max} - S_{min}} \qquad \text{(See Figure 1)}$$

The terms in the ratio shall be measured in accordance with the methods of paragraph 4.6.7.

3.1.4.2 Signal-to-background-shading ratio.- The signal-to-background-shading ratio as used herein is defined as the ratio:

$$R_B = \frac{S_{max}}{B} \qquad \text{(See Figure 1)}$$

S_{max} shall be measured in accordance with the methods of paragraph 4.6.7., and B, the maximum peak-to-peak background shading, shall be measured on an A-scope in accordance with the methods of paragraph 4.6.6.

3.1.5 Grey levels.- The term "grey levels" as used herein, denotes the number of different shades which can be written into the storage tube, read out of the storage tube, portrayed on a display, and the difference of which can be distinguished by the eye when viewing the display. Reference black and peak white shall be considered as two of the shades or grey levels.

3.1.6 Blemish.- The term "blemish" as used herein denotes a localized imperfection of the storage surface which may appear as a light or dark area in the displayed output from the storage tube. Information cannot be written or stored on a blemish area to the same degree as in an adjacent area of the storage surface.

3.1.6.1 Size of blemish.- A blemish is defined as having a size "S" if the reading raster can be positioned so that evidence of the blemish shows up on no more than "S" scanning lines on the display. The size "S" refers to the largest dimension of the blemish. The reading raster must consist of a minimum of 840 equispaced active scanning lines.

3.1.7 Feed-through.- The term "feed-through" as used herein denotes the appearance in the output of the storage tube of spurious signals due to writing beam electrons.

3.1.8 Decay.- The term "decay" as used herein denotes a decrease in magnitude, or change in configuration, of stored information by any cause other than erasing or writing.

3.1.8.1 Dynamic decay.- Dynamic decay is decay caused by an action such as that of the reading beam, ion currents, field emission, or holding beam.

3.1.8.2 Decay time.- Decay time is the time interval starting immediately after a signal is written and ending when the stored signal has dynamically decayed to ten percent of its maximum value.

3.1.9 Overwriting.- The term "overwriting" as used herein denotes the conditions which occur in the storage tube when excessive writing modulation is used with particular writing bias and storage element parameters. Overwriting shall be considered present if a decrease of output from a particular stored signal is observed upon the second or subsequent writing sweeps with writing bias and modulation constant. Overwriting can be observed on a display as an apparent decrease in information stored on the storage surface as the writing sweep passes over information previously written. This effect can also be observed on an "A-scope" by the decrease in signal amplitude as read from a storage tube when the writing sweep passes over information previously written.

3.1.10 Signal buildup.- The term "signal buildup" as used herein denotes the condition which occurs when the maximum signal amplitude is obtained subsequent to writing the signal to be measured rather than immediately after the writing.

3.1.11 Signal output.- The term "signal output" as used herein denotes the amount of signal output current available by observing one range ring on a horizontal line through the center of the storage surface area under a stated set of writing, reading, and decay conditions, using a calibrated amplifier.

3.1.12 Erase time.- The term "erase time" as used herein denotes the time required (during a specified erasing procedure) to reduce the amplitude of the signal output due to written information to ten percent (10%) or less of the amplitude of the maximum signal output after writing.

3.1.13 Range rings.- The term "range rings" as used herein denotes a synchronized pulse whose half-amplitude duration is 1.0 ± 0.1 microseconds and is used to intensity modulate the writing-gun beam of the storage tube.

3.1.14 Maximum writing video drive (Saturated writing level).- The term "Maximum writing video drive" as used herein denotes the maximum unblanking-to-peak video signal that can be applied to grid No. 1 of the writing gun without producing feed-through or overwriting.

3.1.15 Gas ratio.- The term "gas ratio" as used herein is a measure of the degree of vacuum in the storage tube. The ratio shall be the ratio of the current generated due to gaseous ions, to the grid No. 2 current.

$$\text{Gas ratio} = \frac{I_n \text{ (ua) minus } I_L \text{ (ua)}}{I_{c2} \text{ (ma)}}$$

where I_n = negative writing gun grid No. 3 current.

I_L = leakage current to the writing gun grid NO. 3.

I_{c2} = grid No. 2 current.

3.1.16 A-scope.- The term "A-scope" as used herein denotes a Tektronix 545, or equal, oscilloscope.

3.1.17 Display.- The term "display" as used herein denotes a television display with a CRT of at least 12 inches nominal diameter, employing a scan frequency of 945 lines per frame, a 2:1 interlace ratio, and a frame frequency of 30 frames per second. Resolution of the CRT shall be adequate for clear visibility of raster line structure. Brightness of the CRT shall be adequate for comfortable viewing in the ambient illumination of the test area.

3.2 Equipment and services to be furnished by the contractor.- Each tube furnished by the contractor shall be complete in accordance with all specification requirements. Any item or part necessary for proper operation in accordance with the requirements of this specification shall be incorporated even though that item or part may not be specifically provided for or described herein. All features required to meet performance requirements shall be incorporated even though that feature may not be specifically provided for or described herein.

3.2.1 Services and test equipment.- The contractor shall furnish all services and test equipment required in connection with testing and establishing proof of compliance with specification requirements other than the equipment specified in paragraph 3.3. The contractor's test equipment shall not be used as a standard for Government acceptance of storage tubes until certified by the Government.

3.3 Equipment and services to be furnished by the Government.- The Government will conduct qualification tests in an RBDE-3 system installed at a Government facility, as specified in paragraph 4.4.2, in order to certify the contractor's test equipment for production testing. The contractor shall participate in and witness those tests.

3.4 General requirements.- Each storage tube provided under this specification shall meet all requirements stated herein when installed and operating in an RBDE-3 Scan Converter whose controls are set within their normal adjustment range.

3.4.1 Mechanical requirements.- Each tube shall be constructed in accordance with Figure 2, 7539 Storage Tube Dimensional Outline. No deviation shall be made without specific Government approval.

3.4.1.1 Drop-test requirements.- This shall consist of dropping the boxed tube onto a concrete floor from a height of three feet. The boxed tube shall be dropped four times, landing on the top and bottom and once on each of two adjacent sides. After 24 hours the production tests (4.4.4) shall be repeated to determine if damage has resulted from this drop test. This one-time container drop test shall be repeated for each change in packing material or packing method until the packing material and packing method have been accepted by the Government.

3.4.2 Electrical requirements.- Each tube shall be constructed to receive the electrical connections as specified in Figures 2 and 3, herein.

3.4.3 Operational requirements.-

3.4.3.1 Resolution.- Each tube, when adjusted to the standard conditions as specified in paragraph 3.4.4 through 3.4.4.3, shall produce a display in which a test pattern consisting of 150 equispaced concentric range rings, approximately centered on the storage surface, are clearly resolved over the whole storage surface area, as viewed on a display. The writing video gain shall be adjusted just below the point at which feed-through from the writing beam begins to be evident on the display, The method of measurement shall be in accordance with paragraph 4.6.7, (a), (b), and (g).

3.1.3.1.1 Relative response.- Each tube shall have a relative response equal to or greater than fifty percent (50%), when viewing a horizontal line through the center of the storage surface area while meeting the requirements of paragraph 3.4.3.1. The method of measurement shall be in accordance with paragraph 4.6.7, (a), (b), (c), (d), (f), and (g).

3.4.3.2 Signal-to-shading ratio.- Each tube, when adjusted to the standard conditions as specified in paragraph 3.4.4 through 3.4.4.3, and using a test pattern consisting of 25 +5 equispaced concentric range rings, with the video gain adjusted just below the point at which feed-through from the writing beam begins to be evident on the display, shall have signal-to-shading ratios equal. to or greater than the following:

(a) R_S equals five (5) within the area of a circle co-centered with the storage surface, and whose diameter is half that of the storage surface.

(b) R_S equals four (4) within the area of a circle co-centered with the storage surface, and whose diameter is three-quarters (3/4) that of the storage surface, while meeting the condition of (a) above;

(c) R_S equals three (3) within the area of a circle co-centered with the storage surface and whose diameter is seven-eights (7/8) that of the storage surface, while meeting the conditions of both (a) and (b) above.

The method of measurement shall be in accordance with paragraph 4.6.7 (e).

3.4.3.2.1 Signal-to-background-shading ratio.- Each tube shall have a signal-to-background-shading ratio equal to or greater than seven and one-half to one (7½:1), while meeting the requirements of paragraph 3.4.3.2. For ease of measurement, the value of the maximum background variation "B" shall be determined while restricting the bandwidth of the video amplifier to 4.5 MHZ. The method of measurement shall be in accordance with paragraph 4.6.6.

3.4.3.3 Blemishes.- Each tube shall meet the following requirements for both obscuring type and non-obscuring type blemishes under the conditions specified in paragraph 3.4.3.4.

3.4.3.3.1 Obscuring type blemishes.- Each tube shall be limited to obscuring type blemishes as follows:

(a) No obscuring type blemish large enough to interrupt more than one of 150 equispaced concentric range rings approximately centered on the storage surface, and

(b) No more than five (5) interruptions of range ring/s in a display of 150 concentric range rings approximately centered on the storage surface, and

(c) No more than three of these five obscuring type blemishes in a cluster where the diameter of a circle enclosing the cluster is less than ten percent (10%) of the storage surface diameter.

The method of measurement shall be in accordance with paragraph 4.6.5.

3.4.3.3.2 Non-obscuring type blemishes.- Any blemish with a maximum dimension not exceeding the width of one scanning line, and with an amplitude not exceeding seven and one-half percent (7½%) of the signal output as specified in paragraph 3.4.3.5, shall not be counted. For other than these uncounted blemishes, each tube shall be limited to the quantities of non-obscuring type blemishes as follow:

(a) No non-obscuring type blemish that produces a signal output greater than fifty percent (50%) of the signal output as specified in paragraph 3.4.3.5.

(b) No non-obscuring type blemish greater in size than four (4) scanning lines.

(c) The total number of non-obscuring type blemishes shall not exceed five (5) in number of which:

1. No more than three shall have a size greater than three scanning lines, and

2. No more than three shall appear in a cluster where the diameter of a circle enclosing the cluster is less than ten percent (10%) of the storage surface diameter.

The method of measurement shall be in accordance with paragraph 4.6.4.

3.4.3.4 Decay time.- Each tube when adjusted to meet the standard conditions as specified in paragraph 3.4.4 through 3.4.4.3, shall have a decay time of no more than 72 seconds and no less than 48 seconds at an azimuth rotation rate of five (5) rotational periods per minute, while observing a horizontal line through the center of the storage surface area. The decay in one rotation period, after writing for five rotation periods, shall be in the range of 40% to 60%. The signal shall be written only five (5) times before the measurement is made and the maximum amplitude of the signal shall be the peak amplitude measured after the last writing. The method of measurement shall be in accordance with paragraph 4.6.3 through 4.6.3.5.

3.4.3.5 Signal output.- Each tube, when adjusted to meet the standard conditions as specified in paragraph 3.4.4 through 3.4.4.3, shall have a signal output equal to, or greater than, 0.5 microampere. The range ring used for the measurement shall be adjusted to meet the decay requirements of paragraph 3.4.3.4. The method of measurement shall be in accordance with paragraph 4.6.3 through 4.6.3.3.

3.4.3.6 Erase time.- Each tube shall have an erase time equal to or less than fifteen (15) seconds. Each tube shall meet this requirement when the following programmed erase cycle is initiated simultaneously with the removing of a test pattern consisting of 25 + 10 range rings adjusted to meet the decay requirements of paragraph 3.4.3.4.

(a) Ten (10) seconds maximumunder the following conditions:

Backing electrode voltage:	Plus 50 volts (with respect to ground).
Shading electrode voltage:	Minus 25 volts (with respect to ground).
Reading gun grid No. 1 voltage:	Zero volts (with respect to reading gun cathode).

(b) Five (5) seconds maximum under the following conditions:

Backing electrode voltage:	Value established in paragraph 4.6.1 (n).
Shading electrode voltage:	Plus 10 volts (with respect to ground).
Reading gun grid No. 1 voltage:	Zero volts (with respect to reading gun cathode).

(c) Return reading gun grid No. 1 voltage to value used to meet requirements of paragraph 3.4.3.4, decay time.

All tube parameters not specified above shall be adjusted to meet the requirements of paragraph 3.4.4 through 3.4.4.3. The method of measurement shall be in accordance with paragraph 4.6.4.

3.4.3.7 Maximum writing video drive (Saturated writing level).- Each tube, when adjusted to meet the standard conditions as specified in paragraph 3.4.4 through 3.4.4.3, shall have a maximum writing video drive of no more than ten (10) volts and no less than three (3) volts. The writing gun grid No. 1 voltage and blanking level shall be adjusted just below the point at which the writing beam bombardment becomes evident on the storage surface as viewed on the display. The method of measurement shall be in accordance with paragraph 4.6.2 through 4.6.2.3.

3.4.3.8 Gas ratio.- The gas ratio of each tube shall not exceed 0.20 microamperes per milliampere under the following conditions:

Write gun cathode voltage	= Zero volts
Write gun grid No. 2 voltage	= Plus 200 volts
Write gun grid No. 3 voltage	= Minus 25 volts
Write gun grid No. 4 voltage	= Minus 25 volts
Write gun grid No. 1 voltage	= (a) Minus 150 volts and read "I_L" the leakage current to the write gun grid No. 3. (b) Adjust to provide write gun grid No. 2 current "I_{G2}" of approximately 0.5 milliamps and read "I_n" the negative write gun No. 3 current.

All other electrodes floating.

The method of measurement shall be in accordance with paragraph 4.6.12.

(b) Five (5) seconds maximum under the following conditions:

Backing electrode voltage:	Value established in paragraph 4.6.1 (n).
Shading electrode voltage:	Plus 10 volts (with respect to ground).
Reading gun grid No. 1 voltage:	Zero volts (with respect to reading gun cathode).

(c) Return reading gun grid No. 1 voltage to value used to meet requirements of paragraph 3.4.3.4, decay time.

All tube parameters not specified above shall be adjusted to meet the requirements of paragraph 3.4.4 through 3.4.4.3. The method of measurement shall be in accordance with paragraph 4.6.4.

3.4.3.7 Maximum writing video drive (Saturated writing level).- Each tube, when adjusted to meet the standard conditions as specified in paragraph 3.4.4 through 3.4.4.3, shall have a maximum writing video drive of no more than ten (10) volts and no less than three (3) volts. The writing gun grid No. 1 voltage and blanking level shall be adjusted just below the point at which the writing beam bombardment becomes evident on the storage surface as viewed on the display. The method of measurement shall be in accordance with paragraph 4.6.2 through 4.6.2.3.

3.4.3.8 Gas ratio.- The gas ratio of each tube shall not exceed 0.20 microamperes per milliampere under the following conditions:

Write gun cathode voltage	= Zero volts
Write gun grid No. 2 voltage	= Plus 200 volts
Write gun grid No. 3 voltage	= Minus 25 volts
Write gun grid No. 4 voltage	= Minus 25 volts
Write gun grid No. 1 voltage	= (a) Minus 150 volts and read "I_L" the leakage current to the write gun grid No. 3. (b) Adjust to provide write gun grid No. 2 current "I_{G2}" of approximately 0.5 milliamps and read "I_n" the negative write gun No. 3 current.

All other electrodes floating.

The method of measurement shall be in accordance with paragraph 4.6.12.

Write gun grid No. 4 voltage = Plus 2500 volts
Write gun cathode voltage = Zero volts
Backing electrode voltage = Zero volts
All other electrodes floating

The method of measurement shall be in accordance with paragraph 4.6.10.

3.4.3.13 Writing gun zero bias grid No. 2 current.- The writing gun grid No. 2 current of each tube shall not be less than the value given in the following table as determined by the writing gun cutoff (paragraph 3.4.3.11):

Writing Gun Cutoff (volts)	Writing Gun Zero Bias Grid No. 2 Current (uA)
40	400
50	550
60	715
70	880
80	1075
90	1280
100	1500

Each tube shall meet the above requirements under the following conditions:

Write gun grid No. 1 voltage = Minus 150 volts, (zero volts while measurement is being made)

Write gun grid No. 2 voltage = Plus 200 volts

Write gun grid No. 3 voltage = Minus 25 volts

Write gun grid No. 4 voltage = Minus 25 volts

Write gun cathode voltage = Zero volts

All other electrodes floating.

The method of measurement shall be in accordance with paragraph 4.6.11. The purpose of this test is to check the writing gun cathode condition.

3.4.3.14 Storage surface.- Each tube shall have a storage surface area, circular in shape, with a diameter equal to or greater than 95% of the diameter of the boundary ring (see paragraph 3.1.2). The method of measurement shall be in accordance with paragraph 4.6.1 (a) through (d).

3.4.3.15 Ability to withstand scan failure.- Each tube shall withstand operation (without permanent damage) after failure of scanning, providing the writing beam and the reading beam are cut off within 50 milliseconds

after a radial scan failure. In addition, the tube shall withstand operation for five (5) seconds or less (without permanent damage) after failure of azimuth scanning, providing the tube is operating normally in all other respects. In particular, normal operation implies that the writing beam bias and video drive level have been adjusted to no more than just perceptible feed-through and that radial scanning is normal.

3.4.3.16 Overwriting.- Each tube shall display no evidence of overwriting while meeting the requirements of this specification.

3.4.3.17 Signal buildup.- Each tube shall be such that the readout signal, immediately after writing, shall be at least eighty percent (80%) of the maximum signal output as specified in paragraph 3.4.3.5, signal output, while meeting the requirements of this specification. The method of measurement shall be in accordance with paragraph 4.6.3 through 4.6.3.3.

3.4.3.18 Feed-through.- Each tube shall display no evidence of feed-through while meeting the requirements of this specification.

3.4.3.19 Grey levels.- Each tube, when adjusted to meet the standard conditions specified in paragraph 3.4.4 through 3.4.4.3, shall display a minimum of five grey levels. The storage tube shall meet this requirement with an input signal having the following levels:

Level 1	Unblanking level, adjusted such that rotating sweep is just visible.
Levels 2, 3, 4	Three levels equally spaced in amplitude between levels 1 and 5.
Level 5	Amplitude level at which saturation occurs.

3.4.3.20 End of life criteria.- Each tube shall be deemed to have reached the end-of-life when the results of any of the following tests fall outside the limits specified:

Signal output	Same limit as paragraph 3.4.3.5
Decay time	Same limit as paragraph 3.4.3.4, except that decay time shall be no more than 72 seconds and no less than 30 seconds at an azimuth rotation of 5 rpm.

Blemishes	Same limit as paragraphs 3.4.3.3 through 3.4.3.3.2.
Signal-to-background shading	Same limit as paragraph 3.4.3.2.1.
Reading gun zero bias grid No. 2 current	Reading gun zero bias grid No. 2 current shall be no less than 70% of values in paragraph 3.4.3.10.
Writing gun maximum grid No. 1 leakage	Writing gun grid No. 1 leakage shall be no greater than 1.0 uA (see paragraph 3.4.3.12).
Writing gun zero bias grid No. 2 current	Writing gun zero bias grid No. 2 current shall be no less than 70% of values in paragraph 3.4.3.13.
Maximum writing video drive	Same limit as paragraph 3.4.3.7.
Erase time	Same limit as paragraph 3.4.3.6.
Resolution	Same limit as paragraph 3.4.3.1.
Relative response	Same limit as paragraph 3.4.3.1.1.
Read gun cutoff	Same limit as paragraph 3.4.3.9.
Writing gun cutoff	Same limit as paragraph 3.4.3.11.
Gas ratio	Same limit as paragraph 3.4.3.8.

3.4.3.21 Tolerances.- All voltage and current ratings specified shall be within plus or minus five percent (± 5%) unless otherwise stated.

3.4.4 Standard conditions.- The adjustments to standard conditions shall be in accordance with the procedures of paragraph 4.6.1.

3.4.4.1 Reading gun conditions.- The following conditions shall apply to the reading gun of the storage tube.

Scan frequency:	Frames - 30 per second Fields per frame - 2 interlaced Lines per frame - 945 Active field time - 90% ± 1% Active line time - 83% ± 3% Aspect ratio - 1:1
Scan size:	Just overscan useful storage surface area.

Blemishes	Same limit as paragraphs 3.4.3.3 through 3.4.3.3.2.
Signal-to-background shading	Same limit as paragraph 3.4.3.2.1.
Reading gun zero bias grid No. 2 current	Reading gun zero bias grid No. 2 current shall be no less than 70% of values in paragraph 3.4.3.10.
Writing gun maximum grid No. 1 leakage	Writing gun grid No. 1 leakage shall be no greater than 1.0 uA (see paragraph 3.4.3.12).
Writing gun zero bias grid No. 2 current	Writing gun zero bias grid No. 2 current shall be no less than 70% of values in paragraph 3.4.3.13.
Maximum writing video drive	Same limit as paragraph 3.4.3.7.
Erase time	Same limit as paragraph 3.4.3.6.
Resolution	Same limit as paragraph 3.4.3.1.
Relative response	Same limit as paragraph 3.4.3.1.1.
Read gun cutoff	Same limit as paragraph 3.4.3.9.
Writing gun cutoff	Same limit as paragraph 3.4.3.11.
Gas ratio	Same limit as paragraph 3.4.3.8.

3.4.3.21 Tolerances.- All voltage and current ratings specified shall be within plus or minus five percent (± 5%) unless otherwise stated.

3.4.4 Standard conditions.- The adjustments to standard conditions shall be in accordance with the procedures of paragraph 4.6.1.

3.4.4.1 Reading gun conditions.- The following conditions shall apply to the reading gun of the storage tube.

Scan frequency:	Frames - 30 per second Fields per frame - 2 interlaced Lines per frame - 945 Active field time - 90% ± 1% Active line time - 83% ± 3% Aspect ratio - 1:1
Scan size:	Just overscan useful storage surface area.

Grid No. 3 voltage:	Adjust for best focus.
Grid No. 4 voltage:	Ground.

3.4.4.3 Signal electrode (collector) conditions.- The signal appearing on the collector shall be measured and displayed on a system consisting of video pre-amplifier circuitry equivalent to that of figures 4 and 5 of the EIA JEDEC Registered Data for the 7539 storage tube, a display and a Tektronix 545 Oscilloscope (or equivalent). The over-all system frequency response shall be from 1000 Hz to 18 MHz unless otherwise noted.

4. QUALITY ASSURANCE PROVISIONS

4.1 General inspection provisions.- Unless otherwise specified in the contract, all tests and inspection to determine compliance with the electrical and mechanical requirements of the contract specifications shall be made by the contractor and shall be subject to Government inspection. The term "Government inspection", as used in this specification, means that an FAA representative will witness the contractor's testing and inspection, and will carry out such visual and other inspection' as deemed necessary to assure compliance with contract requirements. The Government reserves the right to waive Government inspection at the contractor's plant. If Government inspection is waived, the contractor shall furnish certified test data complying with the approved procedures and forms (4.1.1 and 4.1.1.1) and describing the readings or results obtained during the inspection and tests required for the applicable contract specifications. The test data must demonstrate that the equipment meets contract requirements, include the statement "This certifies that this unit fully meets all technical requirements of the contract", and be dated and signed by a responsible official of the contractor. Certified test data copies shall be furnished as specified for regular test data in 4.1.1.2. Shipment shall not be made until the contractor receives written Government approval of the test data.

4.1.1 Proposed test methods and proposed forms.- Comprehensive test procedures and test data forms (see 4.1.1.1) which the contractor proposes for use in conducting the tests to prove compliance with the contract specifications shall be prepared by the contractor. The test procedures shall be complete and adequate for tests of all equipment requirements and shall include block diagrams of test set-ups. Where special test fixtures are required, schematic diagrams of these fixtures shall be furnished. Three copies of the procedures and data forms shall be furnished the resident FAA representative. If a resident FAA representative is not assigned, the copies shall be sent to the Federal Aviation Administration Contracting Officer issuing the invitation for Bid or Request for Proposal. Copies shall be submitted sufficiently in advance of the contractor's scheduled date for testing to allow the Government 30 days in which to review and evaluate. One copy will be returned to the Contractor, either with a statement that the proposed methods and forms are approved by the Government for use by the Contractor, or with a statement pointing out deficiencies in the proposed methods and

forms. The contractor shall not proceed with testing, using his proposed test methods, without approval of the Government. The approved forms shall be used for preparation of the test data sheets for the testing of all equipment on the contract.

4.1.1.1 Test data forms.- The contractor shall prepare test data forms (see 4.1.1 for approval requirements) for each equipment subjected to test. The title page for each set of test data forms shall show the equipment name, tube type designation and serial numbers, specification number and date, and the contract number and date. The individual test form shall indicate, for each test, the applicable specification paragraph number and performance limits stated therein. The original test data form shall be signed by the contractor's test man and countersigned by the Government representative. Copies may be made by use of carbon paper, or by means of a duplicating process. All copies of a given sheet shall carry identical test data. Blank forms shall be typed, lettered by mechanical means, or printed. Test data for all tests shall, where applicable, contain quantitative information.

4.1.1.2 Copies required.- Two copies of all test data are required. One copy shall accompany the equipment tested. The second copy shall be furnished to the FAA representative. If no FAA representative is present, the second copy shall be sent to the Federal Aviation Administration Contracting Officer issuing the Invitation for Bid or Request for Proposal. See 4.1 for certification requirements when Government witnessing of inspection is waived.

4.2 Facilities for Government inspector.- When a Government inspector is assigned for resident duty (two weeks or longer) at a contractor's or subcontractor's plant, the contractor or subcontractor shall provide the Government inspector with a desk and a file cabinet (with a lock on each), a typewriter, use of telephone (located at the desk) for official business in connection with the contract (cost of long-distance calls made by the inspector to be borne by the Government), and sufficient working space to permit him to perform his required duties adequately. Similar facilities shall be afforded inspectors assigned for periods of 1 to 13 days except that the file cabinet is not required.

4.3 Factory inspection and tests.- The inspections and tests except qualification tests (4.4.2), shall be performed at the contractor's plant.

4.3.1 Production inspection.- Each storage tube to be delivered under the contract shall be given a mechanical and operational inspection. The mechanical inspection shall consist of a visual check of such items as loose or broken parts or connections, metal to glass seals and quality of construction, but does not include detailed measurements as required under one-time tests, paragraph 4.5.1. The operational inspection shall include tests to show compliance with the requirements contained in paragraph 3 through 3.4.4.3 of this specification but these tests shall not be restricted to those listed in section 4 of this specification.

4.4 Classification of tests.- Four classes of tests are required, as follows:

Contractor's Preliminary Tests	(4.4.1)
Qualification Tests	(4.4.2)
One-time Test	(4.4.3)
Production Tests	(4.4.4)

4.4.1 Contractor's preliminary tests.- Prior to the time the contractor notifies the Government that the initial production tube is ready for inspection, and to demonstrate readiness for inspection, he shall make one complete set of all tests required by this specification. These preliminary tests shall be made on one production tube or on one prototype (preproduction) model. The contractor's preliminary tests do not constitute any of the regular qualification tests, one-time, or production tests required by this specification.

4.4.1.1 Preliminary test data.- The contractor shall submit to the Government Contracting Officer a certified copy of the test data covering all the contractor's preliminary tests. This test data may be submitted along with the proposed test procedures and forms under 4.1.1 hereof, but in any case, the test data shall be submitted not less than 10 work days in advance of the date set for inspection pursuant to 4.4.1.2.

4.4.1.2 Notification of readiness for inspection.- After submission of the preliminary test data, and when the contractor has five or more production tubes completed, i.e., tubes produced to meet all specification requirements, he shall notify the Government Contracting Officer in writing that he is ready for Government inspection. Such notification shall be given in time to reach the Government Contracting Officer not less than five work days before the contractor desires inspection to start.

4.4.2 Qualification tests.- Qualification tests shall consist of those tests designated by an asterisk (*) in paragraph 4.5.2. These tests shall be conducted on three tubes selected by the Government from the initial production quantity passing the production tests specified in paragraph 4.4.4. Qualification tests shall then be conducted on these three tubes operating in an RBDE-3 system as specified in paragraph 3.3. The results of the qualification tests shall demonstrate that tubes tested in accordance with paragraph 4.4.4 meet the requirements of this specification when operating in an operational RBDE-3 system before tubes will be accepted on the basis of production testing in the contractor's test equipment. The RBDE-3 system will be adjusted to meet requirements of specification FAA-R-1213. The Government will render a decision as to the certification of the contractor's test equipment for production testing within 30 days after the completion of the qualification tests.

4.4.3 One-time tests.- Out of the entire contract quantity the Government will select one tube which shall be subjected to the one-time tests as listed in paragraph 4.5.1.

4.4.4 Production tests.- Production tests shall consist of those tests designated in paragraph 4.5.2. The Government reserves the right to require additional production tests other than those listed in order to determine compliance with all the requirements contained in paragraph 3 through 3.4.4.3 of this specification.

4.5 Tests.-

4.5.1 One-time tests.- The following one-time tests shall be made:

TEST	PARAGRAPH
Mechanical	3.4.1
Drop-test	3.4.1.1
Electrical	3.4.2
Ability to withstand scan failure	3.4.3.15
Grey levels	3.4.3.19

4.5.2 Production test.- Tests to show compliance with the requirements of this specification shall include, but not be restricted to, those listed below. The tests shall be performed under normal operating conditions as defined in paragraph 3.1.1.

TEST	PARAGRAPH	TEST CONDITION
*Resolution	3.4.3.1	4.6.7
*Relative response	3.4.3.1.1	4.6.7
*Signal-to-shading ratio	3.4.3.2	4.6.7
*Signal-to-background shading ratio	3.4.3.2.1	4.6.6
*Blemishes	3.4.3.3 through 3.4.3.3.2	4.6.4, 4.6.5
*Decay time	3.4.3.4	4.6.3 through 4.6.3.5
*Signal output	3.4.3.5	4.6.3 through 4.6.3.3
*Erase	3.4.3.6	4.6.4
*Maximum writing video drive	3.4.3.7	4.6.2 through 4.6.2.3
Gas ratio	3.4.3.8	4.6.12
Reading gun cutoff	3.4.3.9	4.6.8
Reading gun zero bias grid No. 2 current	3.4.3.10	4.6.8
Writing gun cutoff	3.4.3.11	4.6.9
Writing gun grid No. 1 leakage	3.4.3.12	4.6.10
Writing gun zero bias grid No. 2 current	3.4.3.13	4.6.11
*Signal buildup	3.4.3.17	4.6.3 through 4.6.3.3

4.6.1 Test condition No. 1.- The following test set-up procedure shall be used for this test condition:

(a) Apply all voltages and signals to the tube except reading gun cathode voltage and writing gun cathode voltage.

4.4.4 Production tests.- Production tests shall consist of those tests designated in paragraph 4.5.2. The Government reserves the right to require additional production tests other than those listed in order to determine compliance with all the requirements contained in paragraph 3 through 3.4.4.3 of this specification.

4.5 Tests.-

4.5.1 One-time tests.- The following one-time tests shall be made:

TEST	PARAGRAPH
Mechanical	3.4.1
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Ability to withstand scan failure	3.4.3.15
Grey levels	3.4.3.19

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*Resolution	3.4.3.1	4.6.7
*Relative response	3.4.3.1.1	4.6.7
*Signal-to-shading ratio	3.4.3.2	4.6.7
*Signal-to-background shading ratio	3.4.3.2.1	4.6.6
*Blemishes	3.4.3.3 through 3.4.3.3.2	4.6.4, 4.6.5
*Decay time	3.4.3.4	4.6.3 through 4.6.3.5
*Signal output	3.4.3.5	4.6.3 through 4.6.3.3
*Erase	3.4.3.6	4.6.4
*Maximum writing video drive	3.4.3.7	4.6.2 through 4.6.2.3
Gas ratio	3.4.3.8	4.6.12
Reading gun cutoff	3.4.3.9	4.6.8
Reading gun zero bias grid No. 2 current	3.4.3.10	4.6.8
Writing gun cutoff	3.4.3.11	4.6.9
Writing gun grid No. 1 leakage	3.4.3.12	4.6.10
Writing gun zero bias grid No. 2 current	3.4.3.13	4.6.11
*Signal buildup	3.4.3.17	4.6.3 through 4.6.3.3

4.6.1 Test condition No. 1.- The following test set-up procedure shall be used for this test condition:

(a) Apply all voltages and signals to the tube except reading gun cathode voltage and writing gun cathode voltage.

(l) Apply writing video signals consisting of 25 ± 10 equispaced concentric range rings per active scan, and adjust as in step (j).

(m) Adjust reading gun grid No. 1 voltage so that output signal decays 50% + 10% in one rotation period.

(n) Adjust backing electrode voltage so as to meet decay time requirements of paragraph 3.4.3.4. If necessary, repeat steps (m) and (n).

(o) Erase storage surface.

4.6.2 Test condition No. 2.-

4.6.2.1 Using a write video signal containing a single range ring per active scan at approximately 0.5 radius, increase the writing video gain until just below the point at which feed-through from the writing beam begins to be evident on the display.

4.6.2.2 Measure the writing video signal amplitude (unblanking level to peak). Record as maximum video drive.

4.6.2.3 Erase after this test.

4.6.3 Test condition No. 3.-

4.6.3.1 Use a writing video signal containing a single range ring per active scan at approximately 0.5 radius.

4.6.3.2 Adjust reading gun grid No, 1 voltage so that, after writing for five (5) rotation periods only, the output signal decays to a value in the range 40% to 60% in one rotation period. Erase and allow continuous writing for only five rotation periods.

4.6.3.3 Observe one horizontal line (through the center of the storage surface area) of the reading signal and record written pulse amplitude immediately after writing and again at its maximum value. Record maximum amplitude as signal current. Start timing when observed signal is written. Calculate and record signal buildup.

4.6.3.4 Turn off writing.

4.6.3.5 Record time when pulse amplitude decays to 10% as Decay Time. Erase after this test.

4.6.4 Test condition No. 4.- Simultaneously with turning the writing video off, initiate and carry out the erase cycle as follows:

(a) Set backing electrode voltage to plus 50 volts with respect to ground, shading electrode voltage to minus 25 volts with respect to ground, and reading gun grid No. 1 voltage to zero volts with respect to reading gun cathode.

(b) After 10 seconds maximum, set backing electrode voltage to the value established in paragraph 4.6.1 (n), set the shading electrode voltage to plus 10 volts with respect to ground, and set reading gun grid No. 1 to zero volts with respect to reading gun cathode.

(c) After 5 seconds maximum, adjust reading gun grid No. 1 voltage to the value determined in paragraph 4.6.3.2. Measure the amplitude of the residue of the stored signal in percent of initial output signal amplitude and record. Measure the size and amplitude of all non-obscuring blemishes and record.

4.6.5 Test condition No. 5.- In evaluating the tube for obscuring type blemishes decrease writing gun grid No. 1 bias so as to lightly write a solid PPI pattern on the storage surface. Obscuring type blemishes will show up as detectably dark areas. Record blemishes. Set up tube as specified in paragraph 4.6.1 (j).

4.6.6 Test condition No. 6.- Remove the writing video, measure peak-to-peak background shading "B" (illustrated in Figure 1). Using this value of B and the value of S_{max} obtained from 4.6.7 (e), calculate the signal-to-background-shading ratio, R_{s_b}, as specified in 3.1.4.2. NOTE: Erase prior to performing this test. During the test, restrict the reading video bandwidth to 4.5 MHz.

4.6.7 Test condition No. 7.- The following procedure shall be used for this test condition:

(a) Using writing video signal of 150 equispaced range rings per active scan, slowly increase writing video gain until just below the point at which feed-through from writing beam beings to be evident on the display.

(b) By visual inspection of the display, readjust both writing and reading beam focus control settings for best focus.

(c) Observing the output signal of a horizontal line through the center of the storage surface as displayed on the line selector oscilloscope, measure and note the average peak-to-peak value of the maximum range ring signal output. Moire and beat effects may be "averaged out" by slow manual oscillation of the "selected" line position.

(d) Repeat steps (b) and (c) using writing video signal consisting of 25 + 10 equispaced range rings per active scan.

(b) After 10 seconds maximum, set backing electrode voltage to the value established in paragraph 4.6.1 (n), set the shading electrode voltage to plus 10 volts with respect to ground, and set reading gun grid No. 1 to zero volts with respect to reading gun cathode.

(c) After 5 seconds maximum, adjust reading gun grid No. 1 voltage to the value determined in paragraph 4.6.3.2. Measure the amplitude of the residue of the stored signal in percent of initial output signal amplitude and record. Measure the size and amplitude of all non-obscuring blemishes and record.

4.6.5 Test condition No. 5.- In evaluating the tube for obscuring type blemishes decrease writing gun grid No. 1 bias so as to lightly write a solid PPI pattern on the storage surface. Obscuring type blemishes will show up as detectably dark areas. Record blemishes. Set up tube as specified in paragraph 4.6.1 (j).

4.6.6 Test condition No. 6.- Remove the writing video, measure peak-to-peak background shading "B" (illustrated in Figure 1). Using this value of B and the value of S_{max} obtained from 4.6.7 (e), calculate the signal-to-background-shading ratio, R_{o}, as specified in 3.1.4.2. NOTE: Erase prior to performing this test. During the test, restrict the reading video bandwidth to 4.5 MHz.

4.6.7 Test condition No. 7.- The following procedure shall be used for this test condition:

(a) Using writing video signal of 150 equispaced range rings per active scan, slowly increase writing video gain until just below the point at which feed-through from writing beam beings to be evident on the display.

(b) By visual inspection of the display, readjust both writing and reading beam focus control settings for best focus.

(c) Observing the output signal of a horizontal line through the center of the storage surface as displayed on the line selector oscilloscope, measure and note the average peak-to-peak value of the maximum range ring signal output. Moire and beat effects may be "averaged out" by slow manual oscillation of the "selected" line position.

(d) Repeat steps (b) and (c) using writing video signal consisting of 25 + 10 equispaced range rings per active scan.

(c) Slowly make writing gun grid No. 1 more positive until evidence of writing beam bombardment just appears on the display.

(d) Record value of writing gun grid No. 1 voltage as Writing Gun Cutoff.

4.6.10 Test condition No. 10.- Apply voltages as specified in paragraph 3.4.3.12 to storage tube. Measure the writing gun grid No. 1 leakage with an RCA WV84 Microammeter or equivalent.

4.6.11 Test condition No. 11.- Apply voltages as specified in paragraph 3.4.3.13 to the storage tube. Set the writing gun grid No. 1 voltage to zero volts, record writing gun zero bias grid No. 2 current and return writing gun grid No. 1 to minus 150 volts.

4.6.12 Test condition No. 12.- Apply voltages as specified in paragraph 3.4.3.8 to the storage tube. Set the writing gun grid No. 1 voltage to minus 150 volts and read "IL", the leakage current to the writing gun grid No. 3. Adjust the writing gun grid No. 1 voltage to provide a grid No. 2 current "I_{G2}" of approximately 0.5 milliamps. Read "In", the negative writing gun grid No. 3 current. Calculate the gas ratio as specified in paragraph 3.1.16.

4.6.13 Test condition No. 13.- The following procedure shall be used for this test condition:

(a) Use a writing video signal consisting of a step function of five (5) equal increment steps. These five steps shall occur within the area of 40 to 60 percent of the radius of the storage surface.

(b) Slowly increase the writing video gain to the point at which the maximum amplitude step begins to saturate as viewed on the display.

(c) Observe the display during one rotation of the azimuth sweep.

5. PREPARATION FOR DELIVERY

5.1 Packing shall be in accordance with MIL-E-75, and shall meet the test specified in 3.4.1.1, herein. Each tube shall be individually boxed and adequately marked. Handles, if provided, shall be on the ends of the container.

5.2 The Government will supply shipping instructions upon request from the contractor at the time the storage tubes are ready for shipment. The Government will not be responsible for shipment, storage, and handling of the tubes prior to final acceptance.

6. INDEX (Alphabetical)

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For Figures 2 and 3, see Pages 29-30.

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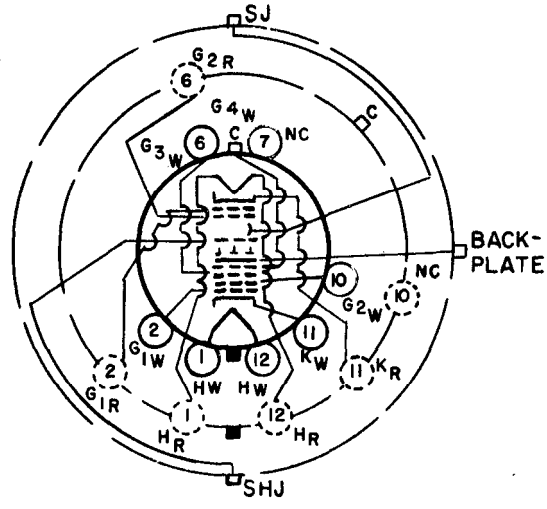
BASING DIAGRAM



WRITING SECTION

End View of Duodecal 7-Pin Base Depicted by Solid Lines

PIN 1: HEATER
PIN 2: GRID NO. 1
PIN 6: GRID NO. 3
PIN 7: NO CONNECTION
PIN 10: GRID NO. 2
PIN 11: CATHODE
PIN 12: HEATER

CAP ON WRITING GUN SIDE OF FLANGE
(Cap located on side of tube opposite base key 1: GRID NO. 4
EXTERNAL CONDUCTIVE COATING.

READING SECTION

End View of Duodecal 6-Pin Base Depicted by Dashed Lines

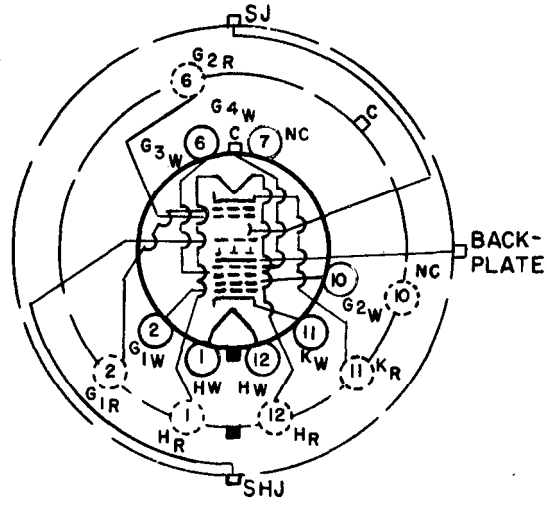
PIN 1: HEATER
PIN 2: GRID NO. 1
PIN 6: GRID NO. 2
PIN 10: NO CONNECTION
PIN 11: CATHODE
PIN 12: HEATER
6: EXTERNAL CONDUCTIVE COATING

TARGET SECTION

FLANGE: BACKPLATE
CAP ON READING GUN SIDE OF FLANGE (Cap located on side of tube over base key): SHADING ELECTRODE
CAP ON READING-GUN SIDE OF FLANGE (Cap located on side of tube opposite base key): OUTPUT-SIGNAL ELECTRODE

FIGURE 3 7539 STORAGE TUBE BASING DIAGRAM

BASING DIAGRAM



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End View of Duodecal 7-Pin Base Depicted by Solid Lines

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PIN 12: HEATER

CAP ON WRITING GUN SIDE OF FLANGE
(Cap located on side of tube opposite base key 1: GRID NO. 4 EXTERNAL CONDUCTIVE COATING.

READING SECTION

End View of Duodecal 6-Pin Base Depicted by Dashed Lines

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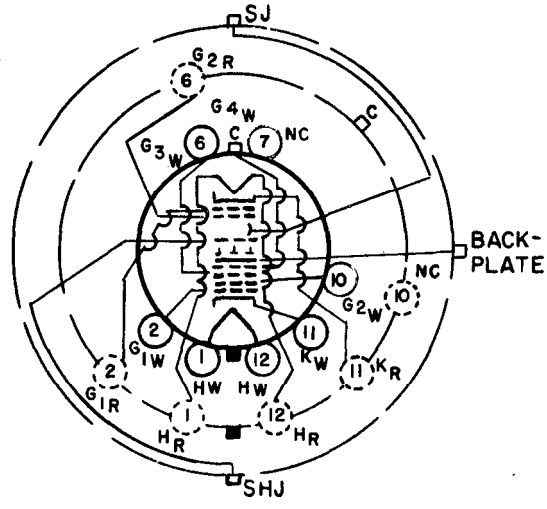
PIN 6: GRID NO. 2
PIN 10: NO CONNECTION
PIN 11: CATHODE
PIN 12: HEATER
6: EXTERNAL CONDUCTIVE COATING

TARGET SECTION

FLANGE: BACKPLATE
CAP ON READING GUN SIDE OF FLANGE (Cap located on side of tube over base key): SHADING ELECTRODE
CAP ON READING-GUN SIDE OF FLANGE (Cap located on side of tube opposite base key): OUTPUT-SIGNAL ELECTRODE

FIGURE 3 7539 STORAGE TUBE BASING DIAGRAM

BASING DIAGRAM



WRITING SECTION

End View of Duodecal 7-Pin Base Depicted by Solid Lines

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PIN 7: NO CONNECTION
PIN 10: GRID NO. 2
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PIN 12: HEATER

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READING SECTION

End View of Duodecal 6-Pin Base Depicted by Dashed Lines

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PIN 2: GRID NO. 1
PIN 6: GRID NO. 2
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PIN 11: CATHODE
PIN 12: HEATER
6: EXTERNAL CONDUCTIVE COATING

TARGET SECTION

FLANGE: BACKPLATE
CAP ON READING GUN SIDE OF FLANGE (Cap located on side of tube over base key): SHADING ELECTRODE
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FIGURE 3 7539 STORAGE TUBE BASING DIAGRAM